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CONTENTS

FOREWORD

The proceedings report the information presented at the Conference on Utilization of Rice held at the Southern Regional Research Laboratory in New Orleans. The conference was cosponsored by The Rice Millers' Association and the Southern Utilization Research and Development Division. It was attended by over 40 representatives of the rice milling industry, rice growers, associated industries, manufacturers, federal and state laboratories, as well as staff members of the Southern Regional Research Laboratory.

The proceedings contain reports on: the current programs of the Western and Southern Utilization Divisions on rice; improved techniques for drying rice; humidity control in rice milling; use of rice hulls for feed purposes; and problems of the rice industry.

The statements contained in the speeches reproduced in these proceedings of the Conference are those of the speakers and do not necessarily indicate or reflect the views of the U.S.D.A.

Conference On Utilization of Rice

INTRODUCTORY REMARKS

C. H. Fisher, Director
Southern Utilization Research and Development Division
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Good morning—I'm happy to see so many of you here today for this conference on the utilization of rice. None of my duties gives me greater pleasure than that of welcoming industry groups, such as this, to the Southern Division to discuss industry problems and the role of research in solving them. We are grateful because you have taken time from busy schedules—and in some instances travelled great distances—to consider research on the processing and utilization of rice.

This is not the first conference of this kind to be held in New Orleans. A "Research Conference on Processing and Milling of Rice" was held in the Southern Laboratory on March 15-16, 1950. It was attended by 41 representatives of industry as well as members of universities, state experiment stations, and various units of the U. S. Department of Agriculture. This was the first meeting of this kind ever held in the United States. The Rice Technical Committee was formed in 1950, spearheaded by the efforts of our Dr. A. M. Altschul. This committee gradually evolved into the present "Rice Technical Working Group," which helps coordinate all types of rice research.

The Informal Rice Working Group was organized at a conference in the Southern Laboratory on June 25, 1952. The principal function of this Group was to facilitate the exchange of information on utilization research between the industry and the Southern Laboratory. Mr. Wm. Reid of the Rice Millers' Association, who has helped in arranging the present conference, was active in organizing the 1952 meeting.

The last two rice conferences with industry in the Southern Laboratory were held December 9, 1954 and November 18, 1955.

Because these conferences were held some time ago, it might be well to mention briefly the role of the utilization research performed by the four USDA Regional Research Laboratories. With the establishment of the four Regional Research Laboratories in 1941, utilization research became an organized and important part of the program of the U. S. Department of Agriculture. Utilization research has these general objectives: To help farmers derive more income from their crops; to help industry convert agricultural raw materials into new and improved products; and to lower processing costs and improve the quality of farm-derived products.

Both the Western Laboratory in Albany, California, and the Southern Laboratory conduct a coordinated program of utilization research on rice. Because major emphasis is given to fruits and vegetables in the Western Laboratory and to cotton in the Southern Laboratory, the research effort on rice at each of these Laboratories is a small proportion of the total effort. For example, three or four scientists in SRRL—representing less than 2% of the Division's total program—are doing research on rice.

Although the man-hours devoted to rice research in both the Western and Southern Laboratories have been relatively few, the results have been gratifying and profitable. New knowledge—much of it fundamental—has been provided in dozens of published papers. These have undoubtedly been valuable—even if only indirectly—to many research laboratories and industrial firms. In addition, research on rice at the Western and Southern Laboratories has been responsible for a number of developments of direct value to agriculture and industry. Some of these representative of the Southern Laboratory's efforts, are the accumulation of data on the effects of heat on rice properties; information on the cause and prevention of the souring of rice; determination of the cause of deterioration of stored bran; studies on the properties of rice oil and wax, and development

of efficient methods for their extraction and methods of drying; and need for humidification to obtain optimum milling yields. Those from the Western Laboratory include: such rice food product developments as canned rice, puffed rice, frozen rice products, rice curls, syneresis-resisting products from waxy rice flour; laboratory and plant scale studies on rice drying and storage practices; and more recently the development of improved procedures for artifically drying western-grown rices which are being cooperatively evaluated in the South.

This information and these developments are being applied commercially to some extent, and no doubt will be used by industry more fully in the future.

In speaking of the adoption of research results by industry, I want to emphasize the importance of the commercial operator. Research developments attain their full value only when you and other men like you take them and apply them in your own plants for improvement of processes or the manufacture of new and improved products. This, then, is the principal value of conferences such as this: to bring news of recent developments more quickly to you, the processors, who are in a position to implement this knowledge for your own benefit and that of the consumers and producers, and to bring you and rice research scientists together for an exchange of views so that we can all learn more about your problems, ideas, and research needs at first-hand.

At this point it is appropriate to thank the rice industry and its associations for the interest displayed in research and for friendly cooperation that has helped make our research activities enjoyable and successful. We sincerely appreciate your interest, and we shall continue to strive to make our cooperative efforts profitable in the form of new and improved products and processes.

Thus far I have talked primarily about research of the Western and Southern Laboratories. As you all know, much rice research is done in other organizations. Some work of this kind will be described at this conference. For example, we also have on the program representatives from the state experiment stations who are working along similar lines. These reports, together with reports from industry on rice utilization, should present a well-rounded picture of what is being done and what might be expected to result.

One of the most important parts of the program will be the panel discussion on rice industry problems and utilization research. Several prominent members of your group have been invited to participate in this discussion; we hope to learn from them, and from your questions and comments, a great deal about your ideas of what our research program should be.

Your are invited to visit the laboratories while you are here, meet with the scientists who are working on rice, make suggestions, and bring up any individual problems on which you would like to have advice. We shall also be glad for you to become better acquainted with our work on other commodities, such as cotton and cottonseed, sweetpotatoes, tung, peanuts and sugarcane.

In closing, I wish to say that Dr. M. J. Copley, Director of the Western Utilization Research and Development Division, originally planned to attend our Rice Conference. On learning that this was impossible, Dr. Copley asked me to express his regrets and to give you his greetings. I wish to thank those contributing to the success of this conference. This includes the speakers, our visitors, Mr. R. M. Persell and his colleagues, and our associates in the Western Laboratory. We wish particularly to thank Mr. Wm. Reid and other in the Rice Millers' Association for their many contributions.

We expect and sincerely hope that this rice utilization research conference will prove just as valuable, both to you and to us, and that you will consider it worth repeating in future years.

Again, on behalf of the Southern Division—welcome. We are delighted to have you with us.

PAST AND PRESENT RICE RESEARCH AT THE WESTERN DIVISION

Ernest B. Kester

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Albany, California

ABSTRACT

Since initiation of rice investigations at the Western Division in the fall of 1947, projects in the following categories have been undertaken.

1. Control of fat acidity in rice:
   a. Steam treatment of rough rice and/or rice bran;
   b. Influence of moisture content and storage temperature;
   c. Solvent extraction of brown rice;
   d. Comparison of stone-shelled and rubber roll-shelled rice;
   e. Measurement of lipase activity in rice bran.

2. Product development: Rice curls; expanded rice; frozen cooked white and brown rice; quick-cooking rice — (2 forms); canned rice; instant breakfast cereals; and frozen cream sauces and custards prepared with waxy rice flour.

3. Parboiled rice:
   a. Effect of processing conditions on color, starch solubility, and kernel-expanding properties;
   b. Effect of storage conditions and processing variables on development of acidity and fat oxidation products;
   c. Effect of sulfite added in processing on storage behavior.

4. Composition of rice:
   a. Free amino acids;
   b. Non-amino short-chain plant acids;
   c. Sugars and hemicelluloses.

5. Physical studies of rice: Equilibrium moisture content of various forms of edible whole grain rice such as brown, milled, quick-cooking and parboiled rices.

6. Drying studies of rice (discussed later by Dr. Ramage).

7. Storage studies of rough rice:
   a. Laboratory investigations,
      1. At constant temperatures in the range of 60-100°F. at different moisture levels.
      2. At low temperatures in the range of –20 to +34°F.,
      3. Storage in 1000-bushel bins under ambient conditions at different moisture levels, and with and without periodic changes of interseed atmosphere.

8. Joint project with Foreign Agricultural Service on evaluation of foreign rice samples. (Cooperatively with the Southern, Crops Research, and Human Nutrition Branches of ARS, and with the Grain Division of AMS.

Most of the projects in the above list are essentially complete, but a few of the food products we do not consider completely satisfactory in their present stage of development. The instant cereals would be helped with more protein and possibly enrichment. The quick-cooking rice poses a processing problem—the prevention of toasting during the expansion step. No work is currently being done on this problem but it is anticipated that research being carried out at WU on an OCDM project on fall-out shelter rations will provide the basis for its solution in the future. Our canned rice, with the improvement of kernel separation by rinsing in vegetable oil emulsion, now seems to be a satisfactory product, but we would like to apply the principles we have used in canning white rice to brown rice. We have done exploratory work on canning brown rice. The product looks promising, but more investigation of its processing requirements and stability are needed.

Currently our Laboratory program is concerned with the effect of pre-processing history on the processing behavior of short grain rices.

We have come to recognize that even one variety of rice is not a static entity but may be affected in its processing behavior by growing conditions, including fertilizer applied to the soil, and stage of maturity when harvested, as well as by its storage history. This project is necessarily a cooperative one, and in activating it we had the assistance of the California Rice Experiment Station where the rice was grown and harvested under controlled conditions.

One aspect of this study involves determination of the simultaneous properties of chemical composition, kernel weight, milling yields, chalkiness, and hot paste viscosity of rices at various stages of maturity. For subject material we have series of samples of California rice varieties representing a wide range of harvest moisture. A second topic is the effect of phosphorus and nitrogen fertilizer on the properties of rice harvested at full maturity. A related investigation is exploratory work on the changes in behavior of rice toward water, particularly with respect to past viscosity and amylase activity of rice stored both as rough rice and in the milled state under ambient and controlled temperatures. Because rice continues to climb in peak viscosity at room temperatures and above, even after protracted storage, it appears that complex biochemical reactions may be involved, and further studies on changes in chemical constituents other than the starches—particularly proteins—are contemplated.

"IMPROVED TECHNIQUES FOR DRYING OF WESTERN RICE"

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ABSTRACT

Studies on the drying of rice, carried on over the past several years at the Western Regional Laboratory, have provided information needed to establish optimum conditions for the commercial drying of western-short grain rice. The information developed in this work has been successfully applied on a commercial scale and has resulted in improved drying procedures for plants using conventional dryers. The improved techniques make it practical to obtain large increases in plant drying capacity with existing drying equipment and to reduce breakage of rice during drying. Proper application of the improved techniques can mean large cash savings annually for the rice industry through upgrading of rice quality and reduction of drying costs.

The research findings have been put into a practical form for guidance of dryer operators. Practical control tests have been developed which enable any dryer operator to find the most effective operating conditions for his particular plant. Control tests are necessary because no single set of recommendations on drying conditions can be given to fit all plants and all situations. The control tests involve sampling of rice streams entering and leaving the dryer, drying the samples to milling moisture content in a laboratory-scale sample dryer under conditions that avoid any significant kernel breakage, and determination of the milling quality of the dried samples. The tests can readily be performed by the regular plant crew and require only a small cash outlay for test equipment and milling appraisal charges.

The increased plant drying capacity permits more rice to be dried at optimum maturity. Tests made in the course of these studies showed increased kernel breakage when mature rice is allowed to dry in the field. Results showed that head rice yield of short-grain rice can be increased 3 to 5 percent by harvesting the rice at moisture contents of 23 to 25 as compared with the usual 20 to 21 percent. The additional cost of drying at these higher moisture contents is very small compared to the increased returns from higher head yields.

A considerable number of rice dryers in California are now profitably applying these techniques. Some operators are attempting to

apply the new methods without making the recommended control tests. Discussions with a number of operators show that we have not sufficiently stressed the importance of these tests as a basis for establishing new operating procedures.

Requests for scheduling of additional meetings designed to educate operating personnel in the correct use of the techniques have recently been received from industry. The California Agricultural Extension Service is aiding in this further educational work. Arrangements have now been made for a series of meetings in which personnel of the Western Regional Laboratory will discuss use of the new procedures with farm advisors and dryer operators.

During the past two rice harvests, efforts have been made to determine whether the techniques developed on western rice can be profitably applied to rice types grown in the southern states. These new studies are being carried on by the Southern Regional Laboratory with the cooperation of the Western Laboratory and other USDA and State Agencies concerned with processing of southern rice.

DISCUSSION

Mr. Chalkley: Rice at over 21-22% moisture content gives a high chalk content when dried. can the drying procedures developed at the Western Laboratory for short grain rices be applied to southern-grown rices containing 23-25% moisture?

Dr. Ramage: This is not known. My talk was concerned only with western-grown rice.

Mr. Chalkley: Have you applied your procedures with Calrose or only Colusa?

Dr. Kester: Yes. They have been applied to Calrose but one doesn't get maximum quality. There is some loss in translucency.

Mr. Grigsby: Do you have to increase the bin capacity (reference to drying techniques developed by the Western Laboratory)?

Dr. Ramage: Yes, in some plants. However, other plants cannot use this procedure due to a lack of conveyor capacity.

IMPROVED TECHNIQUES FOR DRYING SOUTHERN GROWN RICE

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The Western Utilization Research and Development Division has developed a procedure for *determining* and *maintaining* more efficient rice drying conditions for California short-grain rice. The procedure has been successfully applied commercially in California rice mills where both capacity and head yields have been increased.

Consequently, the primary objective of the cooperative studies undertaken by the Southern and Western Divisions was to determine the feasibility of applying the Western Divisions procedures to Southern-grown, medium- and long-grain rice. Secondary objectives were (1) to determine whether dryer plant operators could conduct the necessary control tests, and (2) to evaluate statistically the sampling and testing methods. Another objective, which was incidental but which could prove very important, was to determine the effect of drying rice below 12% moisture.

Rice drying studies were conducted in 1958 in Mill A and in 1959 in Mill B. Mill A appeared to be a representative rice drying plant although they had 3 LSU-type dryers operating

in series. This was desirable because it permitted sampling between dryers which would be comparable to sampling within a dryer in plants using single dryers. Mill B was more advanced from the mechanical and engineering viewpoint which was desirable since evaluation of sampling and testing procedures was the primary objective of this plant.

Equipment. The only equipment used for making drying tests aside from that available in a rice dryer plant was a rice **sample-dryer** which contained spaces for 10 round trays, each 1 sq. ft. in area. The sample dryer is equipped with an electrical heating system, a blower, and a control system to deliver air at various temperatures up to 110°F. through each tray at a velocity of 100 feet per minute. Dryer was set for a cycle of 5 minutes on, and 30 minutes off.

Results of tests at Mill A:

Rice Varieties: The medium-grain rice used for the tests was the Zenith variety, and the long-grain rice was Blue Bonnet 50.

Sampling: Samples were taken of the incoming rice of the specific lot being tested as well as samples after each of the three dryers in series during each pass. Each sample constituted about 18 sub-samples. Samples were tempered in closed containers for 24 hours and then mixed in a McClellan mixer. After determining the moisture content, samples were dried to a moisture content of 12% in the sample dryer. Up to 20 drying cycles were required depending on the initial moisture content of the sample. After drying, the samples were tempered for 24 hours before analyzing for milling yields.

Training Dryer Personnel: The answer to one of the objectives was obtained rather quickly. During the initial tests at Mill A, dryer operators were shown how to take samples, how to determine frequency of sampling, how to operate the sample dryer, etc. Before the start of the third test run, dryer personnel were conducting the actual tests.

Tests Conducted and Results: The standard operating procedure at the plant was to maintain a rice temperature of 98° to 102°F. This was accomplished by using air temperatures of 140°F., 130°F., and cooling, respectively, in the three dryers in series for each pass. Tempering times between passes varied from 24 to 72 or more hours. Feed rate was about 400 bbls./hr.

The first test runs for both the medium-grain and long-grain rice were conducted using the *plant standard drying procedure.* Other test runs were then made using air drying temperatures of 120°F., in all three dryers, 130°F. in all three dryers and 140°F., in all three dryers. In all runs cooling for storage was conducted in the third dryer during the last pass only.

In the plant-scale tests on medium-grain rice (Zenith variety), best results were obtained by increasing the feed rate by 1/3, to 530 bbls. per hr., and by using air temperatures of 130°F. in all dryers except the last dryer in the last pass (where cool air was used). Compared with the old method of operation, use of these new conditions resulted in an increase in drying capacity of 35 to 50% and a reduction in drying costs of $0.035 per barrel. The small gains in milling yields, shown by appraisal tests and by actual plant milling of the lots, were within the limits of experimental error and were not considered significant. This method of operation was immediately adopted by the rice mill.

On long-grain rice (Blue Bonnet 50 variety) operating difficulties prevented an appreciable increase in feed rate and prevented maintenance of a steady feed rate. Fastest drying was achieved when air temperatures of 140° F. were used in all dryers except the last dryer in the last pass (when cool air was used). Compared to the plant standard method of operation, use of these new conditions resulted in an increase in drying capacity of about 20%. However, this was not considered a positive result since the milling tests on the long-grain samples tended to be highly erratic.

Tests at Mill B:

The erratic milling results attained with the long-grain rice at Mill A instigated the study to evaluate statistically, the sampling and testing methods of "Experimental Technique." Variability with the long-grain rice was much

greater than with the medium-grain rice. A series of tests was conducted based on statistical design prepared by our Biometrician, E. Fred Schultz, Jr. Purpose of the tests was to answer the following 5 questions:

1. Does the variability lie among the several trays of a sample?
2. Does it arise between samples dried on different days as would be the case if humidities affect the sample drier results?
3. Do the milling results vary from day to day as would be the case if humidity at time of milling were affecting the results?
4. Is the variability already in the large samples as they are removed from the process stream?
5. Do milling operations have consistent type biases which would contribute to the variability of determinations made by different operators?

Answer to the above questions based on the results of the tests are as follows:

1. and 2. The variability among trays dried on the same day is negligible though the variability between trays of the same rice dried on different days (effect of drying days) is detectable.
3. Milling results do vary from day to day.
4. There is detectable, sometimes sizable, variability in duplicate samples caught from the process stream.
5. Milling operators may differ from one another though there is some evidence that the variability actually found between operators could be explained by differences in the days that prevailed and the moisture content of the samples they got.

This work resulted in the determination of sources of variabilities that tend to effect evaluation of rice drying data, thus enabling the design of a more efficient experimental procedure for studying rice drying.

Plant Drying of Long-Grain Rice at Mill B:

Using as near as possible the revised experimental sampling and testing procedure, seven plant-scale drying test runs were conducted to determine optimum drying conditions.

Blue Bonnet rice having moisture contents of 17.6 to 20% was used. The standard drying conditions were the use of air temperatures of 170°, 150°, 140°, 140,° and 90° F. respectively, for passes on through five for each run.

In two of the test runs, these standard conditions were used. In the other 5 test runs, the air temperature was constant for each pass of any one run except for the last or cooling pass. Drying air temperatures of 140, 150, 160 and 170° F. were evaluated. Six to seven passes were required for each run. The rate of rice throughput was increased up to 54% of the standard throughput rate.

For all runs, including the two controls, there was a decrease in head yields between the rice entering the first pass and the rice after the final pass. The controls showed an average decrease of 3.4% in head yield.

Rice dried at 140° F. with no increase in throughput rate showed a similar decrease in head yield. For the run in which 160° air temperature was used the drying rate was increased by 33%. The head yield decreased by only 1% more than that of the controls. For the 170° drying temperature, the throughput rate was increased by 54%, but the head yield however decreased by 3% more than the controls. The run at 150° drying temperature showed a head-yield decrease of 2.2% more than the controls with an increase in throughput rate of only 6%.

Results showed that by varying the drying conditions there was no improvement in head yields, however, a substantial increase in drying rate of 33% was attained with only 1% decrease in head yield over the control. These tests were limited and definitely indicate the need for further tests on long-grain rice particularly at plants which are not considered to be as progressive as Mill B where relatively high temperatures and five passes are used as standard operating conditions. Actually

these limited tests showed that Mill B may be operating near optimum conditions.

Low Moisture Milling:

A laboratory scale study was made at Mill B to evaluate the effects of decreasing rough rice moisture to between 14% and 10%. Results showed that head and total yields are affected by the moisture content of the rice at the time of the laboratory milling. For a 1% decrease in moisture, head and total yields increased approximately 2.5% and 0.7%, respectively. These results lead us to suggest that:

1. Consideration be first given to tempering all rice samples to some standard conditions prior to being milled in the laboratory. If tempering is not practical, consideration should be given to making moisture corrections on the milling yields.
2. Low moisture rice milling to improve head and total yields should be tried on a plant scale.

One company has made several preliminary low moisture plant milling tests, but to date the results are inconclusive.

Estimates were made on the possible increased return to a rice miller by reducing the moisture of the rough rice to 10% instead of to 12%. Values of $0.09 and $0.05 per pound were used for head and broken rice. Allowing for additional drying costs and decrease in weight, a mill handling 500,000 barrels of rice could have an additional return of $100,000 annually or an increase of approximately 23.0 cents per barrel. Moisture regain of milled rice back to 12% could mean an additional return of $100,000 for a total of $200,000.

Successful application of this method could considerably increase a miller's returns with no additional investment in new equipment.

SUMMARY

The studies have shown that:

1. The Western Division's procedures can be applied to improve the drying of Southern-grown medium-grain rice.
2. The dryer personnel can conduct the necessary control tests to apply to Western Division's procedures to improve their rice drying operations.
3. The use of a more efficient experimental procedure can be used to study rice drying.
4. There may be some benefits in drying to moisture contents below 12%.

DISCUSSION

Mr. Broussard: Would any increase in profit due to milling yield gain by virtue of milling at a low moisture content of the rice be offset by the actual weight loss of rice?

Mr. Spadaro: A cost study showed that the economic benefits of the increased head yields more than offsets moisture weight loss. Also, after equilibration of milled rice, any moisture regained would result in additional profit.

Mr. Chalkley: Was only the temperatures passing through the rice controlled? If not, then perhaps the moisture control of the heated air was the controlling factor.

Mr. Spadaro: Air temperature was the only factor controlled; however, at mill "A" it was thought that results were affected by the varying climatic conditions. In these tests the humidity content of the air was recorded.

Mr. Grisby: Do you plan to apply these techniques in other mills? To conduct training (courses)?

Mr. Spadaro: There are no definite plans at the present time. Perhaps the studies will be repeated next season.

CURRENT PROGRAM OF THE SOUTHERN DIVISION ON RICE

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The report given at this meeting should be regarded as a progress report. The results given reflect our present knowledge and opinions and may be subject to correction as new information becomes available.

The emphasis in past years in rice research at SURDD has been primarily concerned with increasing milling economy investigating such subjects as the effect of heat, humidity, and drying procedures on head yields and by-product utilization. Today more emphasis is directed in the Food Crops Laboratory toward a study of the more fundamental characteristics of rice as a food product. We are trying to determine what happens to rice when it is processed as, for example, when it is parboiled, precooked or freeze processed. Also, we should like to find out what constituents in rice determine the cooking and processing characteristics. We know, for instance, that different varieties have different processing characteristics and that the processing characteristics of a given lot of rice do change during aging.

Our current program is concerned with three areas of investigations. One of these, a study of characteristics of foreign rice, is nearing completion. This is a cooperative study with Foreign Agricultural Service, Western Utilization Research and Developement Division, Human Nutrition Division and the Crops Research Division (ARS) and Agricultural Marketing Service. It was planned primarily to determine the relationship of rice in foreign markets to the common varieties grown in this country, to aid domestic exporters and foreign rice consumers. The work was divided, the Human Nutrition Division determined the cooking characteristics; the Crops Research Division the physical measurements of grain, water uptake and iodine color; and the Agricultural Marketing Service determined the grade according to U. S. standards. The chemical analyses of the different types of rices were shared between Western Utilization Research and Development Division and the Southern Utilization Research and Development Division, the Southern Division being responsible for the analysis of long and medium grain rices while the Western Division analyzed the short grain varieties.

It was necessary, first, to develop methods which would be suitable for routine analysis for total starch, amylose and surface lipids in rice. This was the Southern Division's responsibility. In addition to these analyses, the foreign and domestic rices were analyzed for protein, moisture, ash, total lipids, foreign and domestic rices were analyzed for protein, moisture, ash, total lipids, and crude fiber. Sixteen domestic samples and three-hundred foreign rice samples were analyzed at this laboratory, originating from 16 countries in Asia, South America, and Africa. As a very general statement, and there were many exceptions, the foreign rices were lower in grade; contained foreign matter; were poorly milled; in a number of instances contained mixed grains, and showed more evidence of insect contamination than domestic varieties. The amylose content of Asian rices was higher than expected in many instances. It is not possible at this time to summarize any results since they will have to be reviewed by each cooperating agency and statistically analyzed before any correlation between the chemical and physical tests, and the observed cooking and processing characteristics, can be reported.

A second area of investigation is concerned with the study of the chemistry of aging of rice. This study is being held in abeyance this season so that we may give greater attention to the third, which is concerned with determining the effect of gas plasma irradiation on rice.

The gas plasma (electromagnetic) irradiation work is being done in cooperation with the Agricultural Engineering Research Division at Knoxville. Dr. T. E. Heinton, Chief, Farm Electrification Research Branch, Agricultural Engineering Research Division, Beltsville, Maryland, called our attention to the rather unusual effects of plasma irradiation on cotton-

seed, cotton, and soybeans. The principal effect observed was a marked increase in water absorption. It was reasoned that this treatment might lead to a method of preparing a quick cooking rice without a precooking and drying step if a similar effect on rice could be demonstrated. The apparatus is quite simple—it consists of a tube about two feet long and two inches in diameter, sealed on both ends with rubber stoppers holding iron electrodes. Under vacuum, a "glow discharge" is created when high voltage is applied similar to that in the typical neon sign. Our preliminary work with the first milled rice samples irradiated at Knoxville indicated a marked increase in water uptake. Water uptake test is the only criterion we have used to date for evaluation of samples. It consists in soaking the rice samples for thirty minutes in an excess of water at room temperature, then heating for ten minutes in a water bath at 90° C. The amount of water is determined in the "cooked" rice. We have studied only three variables in the irradiation procedure—time, intensity, and the degree of vacuum. At first we had great difficulty in duplicating results since many variables other than these three must be held constant—for example, the time the rice is subjected to vacuum before the current is turned on. Moisture content of rice also seemed to be quite critical and even the location of air inlet for adjusting vacuum seemed to have a marked effect. Even now there are variables in comparing results of different apparently identical apparatus which we have not been able to pinpoint. In general, our results at present indicate that the degree of vacuum (absolute pressure) within the range where the glow discharge is possible (2 to 10 mm) has little effect. Optimum and time intensity have not yet been determined. As a rough estimate, high intensities in the neighborhood of 175 ma for fifteen to twenty minutes would give nearly optimum water absorption according to present data. It should again be emphasized that this is a progress report and these results summarize incomplete data.

Although now in abeyance, we do have a full year's study on aging which might be reported briefly at this time. Experiments were run on Zenith and Bluebonnet-50 rices stored in the rough and milled state at 60° F. and at room temperature. Total protein, protein solubility in salt solution, amylose, starch, water absorption and free fatty acids were determined. Preliminary results showed that the free fatty acid in the oil increased and the water absorption decreased during the nine months' storage period. We do not know the cause of change but have demonstrated quite conclusively that there is a change and that it is easily measurable by water absorption. More exacting tests will be used next year, particularly a study of change in the protein, lipids, free fatty acid and enzyme susceptibility, in an effort to learn more about the nature of the change in rice during aging.

DISCUSSION

Dr. Kester: How hot does the rice get? (Reference is to temperature developed during gas plasma irradiation.)

Dr. Deobald: We do not know.

Dr. Kester: Is there any change in the Brabender viscosity (of gas plasma irradiated rice)?

Dr. Deobald: We have not observed any change.

EFFECT OF VARIABLES UPON MILLING YIELDS

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Several variables in the processing of rice during milling have an effect upon the yield of head rice. The Institute of Science and Technology, University of Arkansas, Fayetteville, Arkansas, under contract with the Southern Regional Research Laboratory, U. S. Department of Agriculture, conducted experiments during the crop years 1949, 1950, and 1951 to determine the degree to which certain of these variables effect head yield. The experiments

were performed with a complete mill of conventional design constructed on a pilot plant scale, located at Stuttgart, Arkansas.

Breakage in milling was found to occur in the stone sheller, the first- and second-break hullers, and the brush. The milling of 167 lots of Blue-bonnet, Rexark, and Zenith varieties yielded the following average breakage data:

Broken on receipt, 9 percent; broken in stone sheller, 5 percent; broken in first-break huller, 5 percent; broken in second-break huller, 5 percent; and broken in brush, 3.5 percent.

The steaming of brown rice before bran removal was found to result in only small gains in average yield of head rice. However, steaming results in appreciable increased yields in the case of rice in which bran adheres tightly to the kernel (for example, storage-damaged rice). The overall effect of steaming is to decrease the amount and intensity of scouring necessary for removal of bran, thereby increasing huller capacity by 10 to 25 percent. The addition of abrasives on most rices did not increase the yield materially. There is a slight increase in yield, however, for heat damaged rice. The use of abrasives increases the huller capacity by 20 to 30 percent. Steam and abrasives together increased huller capacity by as much as 40 percent.

The effect of mill room temperature upon yield of head rice appeared to be minor, except where the temperature of the rice differed considerably from room temperature. Yields decreased with increase in differences between rough rice temperature and room temperature.

The effects of humidity on head rice yields were determined for Zenith, Bluebonnet, and Rexark varieties. It was shown that relative humidity has a significant effect on the efficiency of the milling process. The optimum relative humidity was determined to be approximately 70 percent. At extremely low relative humidities, such as 30 percent, Bluebonnet rice showed an average deviation of 6 percent decrease from optimum yields at 70 percent relative humidity, Rexark, 5.5 percent deviation; Zenith, 4.5 percent deviation; and parboiled Bluebonnet only 0.6 percent deviation.

These effects of relative humidity on the milling yields of rice were explained as logical effects to be expected from a knowledge of the hygroscopic equilibrium of rough rice studied at the Southern Regional Research Laboratory. Since the rices milled in these studies were generally about 12 to 12.5 percent moisture content, the relative humidity of atmosphere necessary to minimize gain or loss of water vapor from the rice during milling is approximately 70-75 percent.

It was demonstrated that control of the relative humidity of the atmosphere in those parts of the milling process where rice comes in contact with large volumes of air, particularly in aspirators and elevators following hullers, yields the same optimum results as when the entire milling room is conditioned or controlled.

DISCUSSION

Dr. Kester: If the effects of relative humidity on head rice yields are as great as illustrated, then the moisture changes must take place rapidly.

Mr. Hogan: After the second huller operation the rice is elevated in temperature and can lose moisture content quite rapidly—I would say that the change is quite rapid—thereby causing checking or susceptibility to mechanical shock.

Mr. Finfrock: Can you account for the sigmoid-type curve for the hygroscopic equilibrium curve of rice?

Mr. Hogan: In general, the sigmoid-type curve is typical for most cereal grains. Several investigators have devised methods for linear presentation of these data. Dr. S. M. Henderson, at Davis, California, has an excellent correlation which he has published.

Dr. Kester: What is approximate breakage of rice coming in from the fields?

Mr. Hogan: There is quite a range of variation in the breakage of rice received from the fields. Our data ranges from approximately 5%-17%. High incidence of breakage can often be traced to weather conditions.

REPORT ON PROBLEMS OF IMPORTANCE TO THE ENTIRE RICE INDUSTRY

TEXAS
Harry Autrey
River Brand Rice Mills
Houston, Texas

SUMMARY

The problems presented below are those formulated by the Research Committee of the R.M.A. at a meeting in Houston on February 26, 1960. The complete committee composed of Messrs. A. A. Barnett, Walter A. Miller, Wayne G. Robertson, Kenneth Keneaster, and Harry Autrey was present

We on the R.M.A. committee realized firstly, that this meeting is a rice utilization conference, secondly, problems presented should be industry problems and not particular problems of individual processors, and thirdly, that there is a great deal of research being conducted by federal, state and private laboratories on direct utilization of rice, such as, industrial uses for rice and its byproducts and also for convenience forms such as quick cooking, canning and frozen products. We have not omitted this phase of utilization from our thinking for we know that new uses and better utilization of rice means a healthier and more prosperous rice industry. Actually, the development of new products and uses for rice is the Number 1 problem on everyone's list for research. However, we have not dwelled on this phase because we are all aware of its importance and we could have dealt only in generalities. Instead, we have tried to select the problems needing answers which will assist in a better rice whether it is used for white milled rice, parboiled, frozen, canned, cereal, baby foods, quick cooking or for brewing beer.

1. *The Rice Hull Problem*—Despite the large amount of information which has been developed on possible uses for rice hulls, there exists no current solution to the economic disposal of this large volume by-product of the rice milling industry. A concerted effort needs to be made to develop rational uses for rice hulls in large quantities.

2. *Chemical and Physical Changes in Rice as a Result of Storage*—Some information has been developed on this subject, but it is believed that much fundamental information still needs to be uncovered so that a clear-cut understanding of the changes which take place can be obtained. Then with this knowledge, research should be directed toward finding methods which will accelerate the development of desirable storage changes and will retard the development of undesirable changes in storage. For example: It has been stated by many that the cooking qualities of rice improve upon storage, and others have said that undesirable changes in color occur with storage.

3. *The Stink Bug Problem*—The rice stink bug continued to cause a great deal of damage to the rice crop, and more effective means of control need to be found.

4. *Smut in Rice*—The incidence of smut in the rice crop is, in some areas, beginning to be quite serious, and more effective means of control are needed.

5. *Weed Seeds*—Although it is admitted that the rice milling industry is largely responsible for not giving the price incentive to the farmers for growing weed-free rice, nevertheless something needs to be done to minimize the amount of weed seeds which occurs in rice. If more economical means of weed control can be developed, perhaps more farmers would utilize them to produce higher quality rice.

6. *Chemical Residues in Rice*—Recent Food and Drug Administration activity and concern over chemical additives in foods, point up the need for re-evaluation of current insect control, weed control and rodent control measures recommended by the USDA and the Agricultural Experiment Stations. Perhaps analytical procedures need to be developed in the course of this re-evaluation to determine if any hazard exists.

7. *Chalky Rice*—Further research needs to be directed toward minimizing or eliminating the presence of chalky grains in rice.

8. *Shelling of Rice During Harvesting and Drying*—A substantial portion of the rice received at mills today is damaged as a result of shelling and breaking in the harvesting and drying operations. Research directed toward minimizing this problem is needed.

9. *Machinery Development for the Cleaning and Milling of Rice to Improve Quality and Yield*—Most of the methods used today in the cleaning and milling of rice are primitive, relatively speaking, and while some may be good, there is a great deal of room for improvement. Perhaps a combination of chemical and mechanical processing will prove to be more efficient.

10. *Development of More Objective Means to Eliminate Human Error in the Grading of Rice*—In cooperation with the Rice Inspection Service and the rice milling industry, methods need to be developed which will give more nearly objective evaluation of the quality of milled rice, brown rice and rough rice. Human judgment in the grading of rice is subject to considerable variability, and wherever possible and practicable, methods of grading should be developed which are more nearly objective.

LOUISIANA

Harry G. Chalkley
American Rice Growers Cooperative Association
Lake Charles, La.

Many of the problems of the rice industry which Mr. Autrey mentioned in his talk on the millers problems are the same for the growers. Our problems are industry wide.

1. *Pesticide Residues.* We need to know whether the fungicides, herbicides, insecticides, defoliants and the like that are now being used in the production of rice are toxic. If there are toxic residues, are they in the straw, hulls, bran, milled rice or where? We are interested in obtaining this information from the standpoint of the human consumption of rice; and the use of foliage, straw, bran and polish in cattle and other animal and poultry feeding.

2. *Fertilizers:* For more intelligent use of fertilizers, we need information to be obtained thru analysis of the rice plant and grain to determine what chemicals are required to promote maximum yield and quality. Soil analyses should be made before and after the application of chemicals as well as after the crop has been grown to determine what mineral depletion has taken place. These results also should be correlated with the different waters (irrigation) supplied.

3. *Drying:* Experimental study is needed on the use of low humidity air for drying. During the early fall we have many days with high moisture when it is almost impossible to dry rice even at excessive temperatures.

Study the effects of moisture removal necessary to bring all rice to storage moisture of 13 to 13½% as to not only the rice grain, but bran, bran oil, rancidity and the stack burning if this removal is accomplished under commercial drying conditions of relatively high moisture.

4. *Insect Control.* Work should be started on insect control in stored rice. Dow EB-5 is supposed to evaporate from the rice and take the moisture with it. Instead it may pull the moisture to the top and result in burned or mildewed rice. Methylbromide, in methylbromide fumigation, tends to accumulate and one may get more than 50 ppm. It then may become necessary to use cyanide fumigation.

LOUISIANA

E. E. Edmundson, Jr.
Edmundson-Duhe Rice Mills, Inc.
Rayne, La.

The most important aspect of rice utilization is its utilization abroad. Rice is not in surplus in the world. There is in the United States an excess of rice in immediate demand. Up to 1954 the U. S. was not burdened with "surpluses" of rice. The industry built up its production facilities when increased rice production facilities were needed and it now deserves

the right to maintain these facilities on a commercial rather than on a subsidized basis.

Almost 50% of the 1960 rice crop must be exported. We are in dire peril of a reduction in exports. Our most immediate problem is, therefore, to find means of increasing our export markets and in getting rice to the places where it is needed. There is a need for more rice in the world. Every effort should be made to find profitable world markets wherever possible, and more rice should be used in the U. S. Government's "give-away" programs to promote good will abroad.

The storage problem is one of the most important problems in the rice industry. There is no waste with rice like there is with potatoes, dried eggs and the like. We conserve what we have. There are stocks for the study of aging problems. There are 30,000,000 bu of rice in New Orleans which has not received a shot of gas (fumigant) in 15 months.

In addition to building up domestic and international commercial markets we should explore the potential for military use. An intelligent view needs to be taken of the possibility for making greater use of rice in national emergencies.

CALIFORNIA

William J. Duffy, Jr.
Rice Growers Association of California and Sutter Basin Ranches
Woodlawn, Calif.

ABSTRACT

The effects of genetics and breeding extend from the beginning to the consumption of rice.

The USDA Rice Research & Marketing Committee has for many years placed its recommendations for basic research in the No. 1 position. We need to know what a kernel of rice is chemically and physically.

In most cases the problems which the industry and the Rice Advisory Committee are recommending are not being expanded and/or initiated. There has been no increase in the budget for rice utilization research for several years. In the intervening time research on rice has "slipped back." Still we have to look to research for the solution of most of the problems that face us.

In California we need: (1) more basic research on the composition and physical properties of rice, and on its physiology; (2) new, better and cheaper methods for enriching rice; and (3) better objective measurements for measuring processing and quality characteristics.

We need more information on our domestic rices and on foreign rices. We need information on industrial uses, new food products, cooking characteristics, and the like. This is needed so we can channel each variety and kind of domestic rice into the specific world market area in which it is wanted. There is no world surplus of rice. Actually, world rice production is falling behind population growth.

We want our part of the export market. We want to know the characteristics of all U. S. varieties and who wants them, who uses them, so we can find a market for them.

More information is needed on how to handle rice that is milled and in bulk. What happens when it is stored for long periods of time? What happens in the holds of ships, in large elevators and bins? The same kind of information is wanted for brown and for parboiled rice. What are the effects of rough handling and the like?

What is the psychology of foreign markets? What are the eating habits of people in foreign countries? What characteristics of rice are they used to?

I don't know whether humidity is an important factor in California in the milling of rice. Some rice is milled under dry conditions. It might be possible to do a better job.

California rice industry people also have interest in the production (rice growing) problems: weed and insect control, pesticide residues and the like.

Laboratory research data sometimes gets buried in technical reports. Laboratory findings should be tried out in "field" tests. It is a very fine thing to "prove up" what you have already found to be true in the laboratory.

RICE UTILIZATION RESEARCH OF CALIFORNIA AGRICULTURAL EXPERIMENT STATION

Dwight C. Finfrock
Rice Experiment Station
University of California
Biggs, California

In the strict sense of the word I do not believe that the University of California is doing any work on rice utilization at the present time.

In the past, Dr. Henderson in the Department of Agricultural Engineering on the Davis Campus has done some very useful work with unheated air drying of rice. His findings were essentially the same as those of Mr. Sorenson's and Mr. Xzin McNeil's of Texas and Arkansas. In California our air is a little hotter and a little drier so Dr. Henderson found we didn't need quite so much of it to do a good job of bin drying.

On the farm, drying of rice in California can be a success or failure depending on the management. If the dockage is removed from the rice that comes from the field and the bins are designed and properly loaded, a good job of drying is a certainty. In the past, however, we have lost rice in storage because recommendations for bin design, loading, and drying were not followed.

Yesterday, we heard mention of problems in areas that are more technically production research. This is an area where we have a very vigorous program at the California Station. I believe our yields will testify to the fact that we do not only have a vigorous program but that our rice farmers are putting our research findings into practice almost before we are sure that we have found them. Research findings in the areas of stand establishment, pest control, plant nutrition, and water management have been used by the California rice farmer to substantially increase his yields. The average yield per acre for California was 4,600 pounds this past crop season, and fields producing 6,000 to 7,000 pounds of rice per acre were not uncommon.

I would like to mention the cooperative work we have done with the Western Utilization Research and Development Division at Albany, California. As Dr. Kester mentioned yesterday it has been our pleasure to cooperate with this group in several of their studies. I am sure that good liaison and close cooperation are vital if we are to get a maximum return for our research dollar. We must avoid costly overlapping and duplication.

I believe we have been able to avoid duplication of research in California by our close relationship between U.S.D.A. and the California A.E.S. groups working with rice.

I wish to emphasize the importance of the chemical composition survey being carried out cooperatively between the Southern and Western Regional Research Laboratories. The need for defining the elusive entities that make up quality is vital if we are to satisfy specific market demands. This is not a simple situation because of the various characteristics desired by different groups of people. The American housewife wants a rice that cooks up dry and fluffy, the Japanese demand a sticky, gelatinous type, and in some areas of the tropics the people demand a rancid rice. This taste for a rancid rice has developed in limited areas of the world where temperatures and humidities are high and storage facilities are poor. Thus, down through the generations these peoples have eaten only rancid rice and have developed a taste for it. This is a rather extreme sample of what can be considered as a high quality characteristic. It does serve to demonstrate the type of knowledge we need if we are to produce rices that will satisfy the demands of specific markets.

Because of the several references that have been made during this conference to production research I am going to take the liberty of giving you an example of the type of applied production research we are doing in California. We are interested in high yields of readily marketable rices. We also are aware that we have a short period time in which to establish the conditions that will lead to a high yield. In our California varieties floral initiation oc-

curs at about 70 to 75 days after planting and the number of floral initials formed will limit our yield. Thus, we are interested in establishing a situation that will lead to the formation of a maximum number of floral initials in any given area. Numbers of plants per square foot, tillers per plant, and florets per panicle are important considerations.

In our plant population studies we have found that as our population increases up to 30 plants per square foot the number of tillers per plant and kernels per head decrease but the numbers of tillers per square foot and grain yield increase. We also observe better weed control with higher population and there is a better opportunity to utilize the light, gases, water, nutrients, and climatic conditions available for maximum yields.

In closing, I would like to emphasize the need to know the effects of our production methods on quality factors. In the work that is being carried on in the Utilization Laboratories we will find methods of measuring the effects of our research findings and production methods on the quality of our rices.

RICE BYPRODUCTS IN ANIMAL FEEDING

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Louisiana State University
Baton Rouge, Louisiana

Rice and rice byproducts have been used extensively in animal feeding. Because of their chemical composition, they are primarily carbohydrate or energy feeds and compete with other carbohydrate feeds for use in animal rations. Whole rice has been successfully used when low enough in price as a feed for all kinds of animals. Because whole rice is primarily a human food, this usage has never been as great as that of the milling byproducts. The availability of rice byproducts is such that these are used extensively in areas where rice is grown and milled but have not gained great usage nationally.

The rice kernels are very hard and are enclosed in hard hulls. Rough rice is nearly as high in fiber as oats and is lower than corn in protein. Compared to corn, rice is very low in carotene and must be supplemented with vitamin A when used to replace corn. Because of the hardness of the kernel it should always be ground to a rather fine meal even for chickens.

For dairy cows ground rice is about equal to ground corn. In fattening cattle and fattening hogs it has been only about three-fourths as valuable as corn. Its value for fattening lambs has been somewhat lower when fed as the only grain. For laying hens ground rough rice has been used to make up about one-third of the mash or to replace about one-half of the corn in the mash. When this is done larger amounts of supplemental vitamin A must be added due to the low content of the rice. If sufficient energy is supplied, rough rice could be used to the same extent in the ration of young chickens.

Rice bran consists primarily of the rice bran and germs removed in the milling of rice for human food along with a small amount of hulls. Rice bran contains about 12.5 percent protein, 13.5 percent fat and 12 percent fiber. It is used in animal feeding in much the same manner as wheat bran even though it is somewhat lower in protein that wheat bran. It is quite comparable to wheat bran in energy content and is as good in this respect as many of the light weight oats that are presently used. Because of its relatively high oil content the storage qualities of rice bran are not very good except during the cooler months of the year. The oil that it contains will become rancid quite easily if conditions of storage are conducive to this. Solvent extracted bran has had the fat content lowered to approximately 3 percent and will store well for long periods. However, the removal of the oil reduces the energy content of the bran and as a result reduces its overall feeding value. Rice bran is quite variable in quality depending on the amount of hulls that it contains.

When rice bran is incorporated into the concentrate mixture for dairy cows to the extent of one-third of the mixture it is equal to wheat bran and is worth about three-fourths as much as corn or small grains. The same values hold

for the use of rice bran in beef cattle and sheep rations. When rice bran makes up one-third or less of swine rations, it has been found to be equal to corn or wheat shorts. If used in larger amounts in swine rations, it has produced soft pork due to the oil content. However, solvent extracted rice bran will not do this. Rice bran can be used to make up one-fourth of the ration of growing and laying chickens provided the other high fiber feeds are kept to a minimum. If the energy content of the ration is adjusted with high energy materials such as animal tallow it has a value equal to corn in broiler or starter rations. Extensive use of rice bran can be made in the growing rations of chickens where high energy rations are not required.

Rice polishings were available at one time. These were as high as rice bran in protein and fat but as low as corn in fiber. They were superior to wheat shorts or middlings as a feed for dairy cattle, beef cattle, swine, or poultry. As was the case with rice bran the oil became rancid quite easily and care had to be exercised to prevent this. In recent years rice polishings have not been available as such but are incorporated into a product called "rice mill byproduct."

Rice mill byproduct or rice mill feed is the entire product obtained from the milling of rice and frequently contains large amounts of hulls. Feed Control Officials have stated that this product should not exceed 30 percent crude fiber. Because of the high fibrous and low energy content of this product, its use has been considerably more restricted than for other rice byproducts. When the ration contains sufficient energy from such materials as corn or molasses, this product gives satisfactory reults with dairy and beef cattle. Its use in swine and poultry rations has been greatly limited by the high fiber content.

Ground rice hulls have been fed to certain kinds of farm animals with some success. There has been many who felt that the use of rice hulls was detrimental because of the high silica content. This probably is true it whole rice hulls are fed. However, when the rice hulls are ground to a medium degree ot fineness they can be fed in considerable quantities with no harmful effects. The two primary uses of rice hulls and rice mill feed has been with cattle and poultry. In cattle the use of some cottonseed meal and urea to supply the protein needs of the animal along with some corn and molasses to supply some energy to the animal has permitted the use of considerable quantities of rice hulls and rice mill feed. The use of such low cost roughages along with some high energy feeds has become quite common in the cattle industry. One of the deterrants to greater usage of these materials has been the relatively small tonnage of the material produced along with its low bulk density. The shipping of such light bulky materials has not gained very great popularity.

In the poultry field rice mill feed and ground rice hulls have been used to make up from 30 to 40 percent of the total ration for growing birds. The purpose has been to supply only limited amounts of the essential nutrients so that maturity could be delayed. This is accomplished by making the ration so bulky with rice hulls that the chicken could not consume enough on full feed to promote maximum growth. This usage was an outgrowth of the system of growing out chickens on a limited feeding program. The high fiber growing rations are being used extensively in several southern states at the present time.

In summary rice and rice byproducts are used extensively in animal feeding. The primary factors limiting their use is the high fiber content of the materials and the relatively low tonnage of the materials produced.

FUTURE RESEARCH ON RICE AT WU

G. O. Kohler
Western Utilization Research and Development Division
Albany, California

ABSTRACT

The reports of the Rice Research and Marketing Advisory Committee and the discussions here at this Conference provide a multitude of industry problems which, if attacked simultaneously, would require many times the manpower available in all of the rice research groups in the country. The problem faced,

then, by the research supervisor is to select problems (1) which are important, (2) on which he can muster ideas for an attack, (3) for which he has or can get qualified personnel and (4) for which he has or can get suitable equipment.

One approach to getting the greatest returns from the research dollar is to utilize techniques and know-how to developed on related commodities. For example, at WU we have been studying wheat proteins over a period of years. We now plan on applying the methodology developed to rice proteins. This will provide basic information on rice composition in accord with the Advisory Committees top priority recommendation. We feel that the information gained may lead particularly to understanding and control of the processing problems (e. g., stickiness) encountered with Western rices since the starch granules are imbedded in a continuous matrix of protein in the rice kernel.

As another example of "borrowing" from another commodity, work should be undertaken to study the estrogenic (female sex hormone) activity of rice bran and oil. We have observed such activity in exploratory tests suggested by our research on the estrogens of forages and wheat. There is a large market for estrogenic materials in the livestock industry where three-fourths of the steers being fattened are currently being treated with stilbestrol, a synthetic estrogen.

Still another example of possible application of developments in other commodities is inert gas storage. Currently there are about one-half million tons of this type of storage capacity being used in the alfalfa dehydration industry. Such a storage process completely controls insect and rodent infestation, eliminates fire hazards and could be expected to reduce weight losses of the stored commodity due to natural respiration. Research is needed to determine its utility for rice storage.

Another high priority recommendation of the Advisory Committee is development of uniform enrichment procedures. While much work has been done by many commercial and other laboratories in the past without great success, we feel that the problem might be attacked from the view point of textile dyeing technology. Research on mordant-like adjuncts and derivatives of additives which would react with the protein or starch of rice might well provide the leads for solution of this difficult problem.

With regard to new rice food products our work in the near future will be restricted to developmental studies on highly stable, precooked type foods suitable for emergency shelter rations. Current work supported by the Office of Civil Defense and Mobilization (O.C.D.M.) is being directed toward wheat products. We feel that because of the low allergenicity of rice, all projected shelters should contain rice foods as well as wheat foods. This O.C.D.M. work eventually may be expected to provide the basis for new cereal foods for general consumption.

The above are but a few of the host of ideas that crowd in on us when we begin to think about the research possibilities on rice. Accomplishment of the objectives is largely a matter of application of brains and manpower and we shall do as much as we possibly can in the years ahead.

PANEL DISCUSSION

Rice Industry Problems and Utilization Research

Harry Autrey, Chairman, River Brand Rice Mills, Houston, Tex.
Florence M. Douglas, C. E. Grosjean Rice Milling Co., San Francisco, Calif.
George B. Blair, American Rice Growers, Lake Charles, La.
William J. Duffy, Jr., Rice Growers Assoc. of California and Sutter Basin Ranches, Woodland, Calif.
Kenneth K. Keneaster, Uncle Ben's, Inc., Houston, Tex.

* * * *

Mr. Reid:

The panel has not been provided with a topic. The term "quality" is suggested as the first subject for discussion.

Mr. Keneaster:

Quality is one of the most difficult things to define. It means many things to many people. In Saudi Arabia some like dark par-

boiled rice, which is not saleable in the United States, but commands a good price there. We are looking for definitions and means of measuring quality to meet needs of customers throughout the world. Grain size is one of the factors to be considered. Uniformity of cooking quality is another factor. Customers who prefer sticky rice want it sticky all of the time. Bolivians prefer stackburned rice. Preferences are traditional, handed down from generation to generation, and research will not change the preferences. Means must be found to meet their requirements.

Mr. Autrey:

Orientals are more conscious of taste of rice than are the people in the rest of the world, which is a factor to be considered along with cooking qualities.

Mrs. Douglas:

In California we have the best tasting rice in the world, though it takes people a long time to realize it.

Mr. Duffy:

The matter of quality is such a relative thing that we have to know what we are talking about before we talk about quality in particular varieties or particular markets. In Advisory Committee work there was a long session on the subject of referring to short grain California rice as "inferior." This "inferior" rice is not in surplus. Quality is relative, and I think it is the most important thing in sale of our product. Quality aimed at a particular market will sell the product.

Mr. Blair:

Grading and correlating grades of rice from throughout the world was discussed by Dr. Deobald. Samples were received from commercial channels of trade. One objective of this study is to learn more about the kind of characteristics different people want in rice. California says its rice is in demand for export. Quality is relative and depends on what the customer wants. What we mean when we say quality is that we are talking about desired consumer characteristics. It does not mean the same to me as to someone in California or South Lousiana or the Carolinas. We lack a better term than "quality." Actually, we mean "characteristics" and especially desired consumer characteristics. People in the United States are sometimes more interested in selling rice than in producing what the customer demands. In this country we can produce rice of any characteristic desired by the consumer. In terms of long, short, medium brown, milled, or under-milled rice we can meet almost any demand in the world.

Mr. Keneaster:

More definite information needs to be obtained on what the consumer thinks is actually important in the rice. Samples from foreign countries may be of low quality as far as we are concerned. Does this mean that these people really want contaminated rice? We need information on what the consumer wants in rice and to know the characteristics of the different varieties, so that we may develop varieties and processing procedures that will yield the products the consumers want.

Mrs. Douglas:

These countries want a good rice from us, yet they obtain poor grades of rice from other countries. I wonder why it is necessary that we have standards so much higher than in other countries.

Mr. Blair:

Some of the rice in international trade in tremendous quantities would not be permitted to get off the dock by our Food and Drug Administration. Perhaps we need sometime in the near future, if we expect to stay in the export market, an expansion of our grades of U. S. rice that will give us a wider range of grades, or a supplementary set of grades (for export) to meet these specific requirements and characteristics. Our range of grades may be too limited. It is easier to sell by standards than by samples. The fellow at the other end would like to know the characteristics he is going to get. Present grades permit several characteristics.

Mrs. Douglas:

Our 3, 4, 5, and 6 grades are reasonably well milled. I believe a meeting will be held in California to try to do something about the standards for export.

Dr. Kohler:

From the quality of foreign rice samples, might not one conclude that the chief quality the countries want is low price?

Mr. Blair:

It would not be any advantage to the United States producers or millers to do a bad job on rice that moves in world trade, since our people are set up to do a good job. Unquestionably it is true that the reason for low quality in much of the rice in foreign markets, as we understand it, is a matter of price. Other countries have not set up equipment, storage, and fumigation facilities such as we have in the United States. Our rice has more desirable and acceptable characteristics, except strictly from the standpoint of price.

Dr. Ramage:

What does this mean from the standpoint of research needs? If quality is defined as what the consumer wants, it is possible that some objective measurements of quality can be worked out. There is relatively little information available on actual objective methods for measuring characteristics of rice, and much research could be done in this field.

Mr. Duffy:

Much of the American rice industry depends on foreign markets. Mr. Blair's remarks on foreign markets are important. We must know more about how to meet export demand in all parts of the world, and our quality in grading is geared to our local markets.

Dr. McKibben:

What can be done in reducing costs at export in the way of less expensive milling, etc.? It would have to have a grade that indicated what it was, but in many parts of the world the cost is one of the factors that the consumer must face. In our own groceries, purchasers are people who are willing to pay for really good quality.

Mr. Keneaster:

There is a limit to the amount of cost reduction. The limiting factor is price paid for rough rice, and the yield you can get from rice even if standards are lowered to where rice is barely milled. Possibilities of reducing cost there are not very great.

Mr. Duffy:

A drastic departure from the subject just discussed, but one of great importance, is the matter of taking advantage of the cross section of the rice industry here today to do somethng about the matter of lag in rice research, particularly in relation to the laboratory portion of the program. What we need is money. It is our only answer. I hated to hear in sessions of the Rice Research and Marketing Advisory Committee and in talks here, "This project has been discontinued." It is pitiful to think that an industry which grosses about ¼ billion dollars a year may be satisfied with utilization research totaling only 7 man-years per year. We are in a position to correct this.

[There ensued an extensive discussion of the need for establishing and operation of a permanent industry liaison committee to promote greater research activity on rice and insure wide dissemination of the findings of such research. Dr. Kohler described the functioning of such a committee which has been set-up by the wheat industry.]

Mr. Blair:

The first priority for several years on rice research (Advisory Committee) has been the physical and chemical characteristics of rice. To me this area is by far the most important area in which we need research. Until we know what a grain of rice is, what is in it, why it reacts the way it does, we can't apply our other knowledge to it. Basic information is a must. All other research depends on this.

Mr. Autrey:

Perhaps some of our industry representatives would like to state a problem.

Mr. Kelly:

One of the biggest quality problems is deterioration of grains in storage. Is it due to fatty acids? Controlled atmosphere in storage may be the solution to the problem. If you stop respiration you stop mold growth.

Mr. Spadaro:

Perhaps the rice industry representatives could hire a research fellow through one of their organizations to work at SU on one of the main problems such as the determination of the characteristics of rice. Several other

industries have fellowships at each of the four regional laboratories.

Mr. Duffy:

This brings to mind something I wanted to mention. An industry committee thinking and acting independently is needed—one that could carry the ball for the research program. Such a committee might be in a position to not only solicit, but disperse funds into research channels. Other industries are spending proportionately more money and the food industries are probably spending more money on food research than the Government. Grants could be solicited and dispersed by an independent group, which cannot be done at present.

Mr. Autrey:

Is there any comment on hulls as by-products?

Mrs. Douglas:

What percentage of fiber do you allow in the bran in the Southern states?

Mr. Autrey:

11% or 12%.

Mr. Kenester:

Half the battle is won in research if a person can really define the problem. Perhaps we on committees are dealing too much in generalizations, rather than in specific problems. We would welcome the assistance of technical people in stating these problems in specific, short-term objectives, rather than a big chunk at one time.

Dr. Watts:

In the broad field of agriculture there are tremendous facilities than can be tapped. Having worked with Advisory Committees at state levels, it has worked very well in our case. A good research man can take your problem and put it in research terms. Some organizations, with a liaison representative, arrange it so that you can talk to one man who in turn informs his own people; he understands our work and he can inform his own people in their language. State Experiment Stations might be considered to do work, as well as Research Laboratories.

Mr. Edmonson:

Work could also be done in foreign countries. If we had a trained man from industry he could help to evaluate what could be done.

Mr. Blair:

I have been pleased in the past four of five years at the development of cooperation, coordination, and lack of duplication of work between the Laboratories, Experiment Stations, Extension Service, and all of the technical people as far as rice is concerned.

Mr. Majors:

Research results and problems have been discussed, but does industry have specific ideas on how information from research can best come down to you? Should the work come to you through special reports, or through demonstrations with mills? What are some of your ideas on that subject?

Mr. Keneaster:

I recommend the Rice Journal as a means of disseminating research, and that this journal be used as quick means of getting the information to the rice industry.

Mr. Duffy:

Extension Service can do a pretty good job in this matter. Recommendations have been made by the Advisory Committee to speed up this effort. Extension Service has been urged to be more vigorous in its effort to pick up useful technical data, color them up, rephrase them, and get them into the hands of the people who need the information. WU has published results in layman's language, and this is commendable.

Dr. Kester:

In rice drying work we have put out strictly technical articles and we did not get the message across to the people it needed to get to. When we tried a popular style release it got to the rice people and I think we are on the right track.

RESOLUTIONS

1. **Be is Resolved:** That the value to the rice industry of conferences on the utilization of rice has been established at this and previous conferences, and that the Western and Southern Utilization Research and Development Divisions be urged to continue to hold such joint conferences with industry.

2. **Be it Resolved:** That the Committee established at this conference be continued on a permanent basis to ensure the continued close liaison between the rice industry and the Western and Southern Utilization Divisions, and to spearhead and coordinate industry efforts to aid, increase and intensify utilization research on urgent problems.

3. **Be it Resolved:** That this conference express its conviction that the physical facilities and research leadership for development of an adequate and effective program on the utilization of rice exist at the Western and Southern Utilization Research and Development Divisions, and recommend: (1) that the U. S. Department of Agriculture greatly expand and intensify research along the lines repeatedly urged by the Rice Research and Marketing Advisory Committee: (2) that this expanded program be quickly instituted with initial emphasis on the areas where the need and promise seem greatest; and (3) that this program include research on composition and physical properties; new and more effective methods for enriching milled rice; measurement of processing characteristics; factors affecting processing characteristics; industrial uses; and new food products.

Attest:

The above resolution was unanimously adopted at the Conference on the Utilization of Rice held at the United States Department of Agriculture, Agricultural Research Service, Southern Utilization Research and Development Division, March 8, 1960.

/s/ William M. Reid
Chairman of the Session
March 8, 1960

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
SOUTHERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION

Program for

CONFERENCE ON THE UTILIZATION OF RICE

March 7-8, 1960

Southern Regional Research Laboratory
1100 Robert E. Lee Boulevard
New Orleans, Louisiana

PROGRAM COMMITTEE

Wm. M. Reid, Rice Millers' Association
R. M. Persell, Southern Utilization Research and Development Division

MONDAY, MARCH 7, 1960

Conference Room

9:20 a. m.		**V. H. McFarlane**, Chairman, SU
9:20 a. m.	Opening Remarks	**C. H. Fisher**, Director, SU
9:30 a. m.	Past and Present Rice Research at the Western Division	**Ernest Kester**, WU
10:00 a. m.	Improved Techniques for Drying Western Grown Rice	**W. D. Ramage**, WU
10:30 a. m.	Intermission	
10:50 a. m.	Improved Techniques for Drying Southern Grown Rice	**J. J. Spadaro**, SU **W. D. Ramage**, WU
11:20 a. m.	Current Program of the Southern Division on Rice	**H. J. Deobald**, FC, SU
11:50 a. m.	Effect of Variables upon Milling Yields	**J. T. Hogan**, SU
12:30 p. m.	Lunch	
2:00 p. m.		**E. L. Patton**, Chairman, SU
	REPORT ON PROBLEMS FROM THE RICE INDUSTRY:	
	Texas	**Harry Autrey** Texas Rice Miller
	Louisiana	**Harry Chalkley** Louisiana Rice Producer
	Louisiana	**Ernest E. Edmundson** Louisiana Rice Miller
	California	**William J. Duffy, Jr.** California Rice Grower

TUESDAY, MARCH 8, 1960

9:30 a. m.		**William M. Reid**, Chairman Rice Millers Association
9:30 a. m.	Rice Utilization Research of California Agricultural Experiment Station	**Dwight C. Finfrock** California AES
10:00 a. m.	Rice Byproducts in Animal Feeding	**A. B. Watts**, Louisiana AES
10:30 a. m.	Future Research at WU	**G. O. Kohler**, FC, WU
10:50 a. m.	Intermission	
11:10 a. m.	Panel Discussion—Rice Industry Problems and Utilization Research	
12:30 p. m.	Lunch at SU	
1:30 p. m.	Tour of Laboratory	

Southern Utilization Research and Development Division

CONFERENCE ON UTILIZATION OF RICE

March 7-8, 1960

ATTENDANCE LIST

Harry Autrey, Engineer, River Brand Rice Mills, Houston, Texas

Howard Bauman, The Pillsbury Co., Minneapolis, Minn.

George B. Blair, Gen. Mgr., American Rice Growers, Lake Charles, La.

J. Otto Broussard, Exec. V. P., Edmundson-Duhe Rice Mill, Rayne, La.

Harry G. Chalkley, V-Pres. American Rice Growers Coop. Association, Lake Charles, La.

Joe R. Dockery, National Advisory Board, Dockery-Farms, Cleveland, Miss.

Mrs. Florence M. Douglas, C. E. Grosjean Rice Milling Co., San Francisco, Calif.

William J. Duffy, Jr., Rice Growers Ass'n. of California, Sutter Basin Ranches, 131 Bartlett Ave., Woodland, Calif.

E. H. Dupre', River Brand Rice Mills, El Campo, Texas

E. E. Edmundson, Jr., Secretary-Treasurer, Edmundson-Duhe Rice Mills, Inc., Rayne, La.

Macon D. Faulkner, Asst. Agr. Eng., L. S. U. Rice Exp. Station, Crowley, La.

Dwight C. Finfrock, Supt. Rice Experiment Station, Univ. of Calif., Biggs, Calif.

Reid M. Grigsby, Economist in Marketing, L. S. U., Baton Rouge, La.

John V. Halick, Chemist, USDA, ARS, CRD, Beaumont, Tex.

J. W. Hancock, President, El Campo Rice Milling Co., Box 110, El Campo, Texas

Austin T. Harrell, Supt. L. S. U. Rice Experiment Station, Crowley, La.

Mrs. M. R. Hayes, Partner, Southern Construction & Mill Supply Co., Rice Mill Builders, 2502 Dundary, Houston, Texas

Vincent J. Kelly, Gerber Products Co., Oakland 3, Calif.

Kenneth K. Keneaster, Dir. of Product Research, Uncle Ben's, Inc., P. O. Box 1752, Houston 1, Texas

Dr. Ernest B. Kester, Western Utilization Res. and Dev. Div., ARS, USDA, Albany, Calif.

Dr. George O. Kohler, Field Crops Laboratory, WURDD, ARS, USDA, Albany, Calif.

M. J. Labry, La. State Rice Milling Co., Abbeville, La.

Stephen J. Loska, Jr., Head, Flour Research Branch, The Pillsbury Co., Minneapolis, Minn.

E. G. McKibben, Director, Agricultural Engrg. Res. Div., Plant Industry Station, Beltsville, Md.

Ira McColloch, Richmond, Texas

Walter McCrea, Jr., Acting Officer in Charge, USDA Grain Division, Room 1401, Masonic Temple Bldg., New Orleans, La.

John J. Mikell, Asst. Director Experiment Station, L. S. U., Baton Rouge, La.

Kenneth R. Majors, Extension Grain Utilization Specialist, Federal Extension Service, NURDD, ARS, USDA, Peoria, Illinois

Walter A. Miller, Rex Rice Co., Inc., Eunice, La.

Charles A. Montague, Jr., Buckeye Cellulose Corp., Memphis, Tenn.

Ruel P. Nester, Extension Agronomist, Agricultural Extension Service, Little Rock, Arkansas

James J. Nicholas, General Manager, Farmers' Rice Growers Coop., San Francisco, Calif.

Dr. W. D. Ramage, Chief, ED. Laboratory, WURDD, Albany, Calif.

William M. Reid, President, The Rice Millers' Association, New Orleans, La.

Wayne G. Robertson, Manager, Farmers Rice Milling Coop., Lake Charles, La.

C. M. Rocca, Pacific International Rice Mills, Inc., San Francisco, Calif.

Harry W. Schroeder, Plant Pathologist, Texas A&M College, College Station, Texas

Jack R. Smith, President, Lake Rice Mill, Lake Arthur, La.

Dupre Spiller, Adv. Mgr., The Rice Journal, New Orleans, La.

R. B. Stone, Jr., Associate Agric. Engr., Agricultural Engineering Research, ARS, Tennessee Agricultural Experiment Station, Univ. of Tenn., Knoxville, Tenn.

Mark F. Vaught, Production Manager, Comet Rice Mills, Houston, Texas

Joseph J. Vincent, Manager, Rough Rice, Supreme Rice Mill, Crowley, La.

A. B. Watts, L. S. U., Baton Rouge, La.

Elizabeth Williams, Specialist Consumer Ed., L. S. U. Agric. Expt. Service, Baton Rouge, La.

P. C. ten Wolde, Vice President, Rickert & Loan, New Orleans, La.

Oscar F. Zebal, Export Manager, Rice Growers Association of Calif., San Francisco, Calif.

Elo. A. Buenger, Jr., Brewers Rice Brokers, Anheuser-Busch, Inc., 314 Girod Street, New Orleans, La.

H. A. Tabary, President, H. A. Tabary Rice Co., 237 International Trade Mart, New Orleans, La.

Jim Coddington, Rice Mkt. News Service, USDA, New Orleans, La.

U. S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
SOUTHERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION
NEW ORLEANS, LA.

FOR IMMEDIATE RELEASE February 23, 1960

Rice Research Conference Scheduled at the Southern Laboratory:

Members of the rice industry will meet with state and federal research workers March 7-8 at the U. S. Department of Agriculture's Southern Regional Research Laboratory in New Orleans to hear reports on rice utilization research and discuss problems of the rice industry.

The meeting was announced by Dr. C. H. Fisher, Director of the Southern Utilization Research and Development Division.

Representatives of the USDA Western Utilization Research and Development Division will report on the rice utilization research program there, and join with representatives of the Southern Division in discussing improved techniques for rice drying. These techniques were introduced first in California, where they are now in wide commercial use, and later adapted to the drying of Southern rice by workers from the Southern and Western Divisions.

Speakers from the Southern Division will describe the current rice research program and discuss humidity control in rice milling.

Industry representatives have been invited to speak on rice utilization, and research workers from experiment stations in the rice-growing states of the South are scheduled to report on rice work at their stations.

Sessions will close with a panel discussion of "Rice Industry Problems and Utilization Research."

All members of the rice industry and others interested in its progress and problems are invited to attend the meeting.

Hotel reservations may be obtained by writing Dr. T. H. Swan, Southern Utilization Research and Development Division, P. O. Box 19687, New Orleans 19, La.

U. S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
SOUTHERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION
NEW ORLEANS, LA.

FOR IMMEDIATE RELEASE March 11, 1960

USDA-Industry Conference Stresses Need For Foreign Markets, Additional Research:

The future of the American rice industry depends largely on the foreign export market, William J. Duffy, Jr., of the Rice Growers Association of California, said during the closing session of the rice utilization research conference sponsored by the Rice Millers' Association and the Southern Utilization Research and Development Division of the U. S. Department of Agriculture in New Orleans, La.

Ways to capture and hold more of this export market, and the need for additional utilization research were the two principal topics of the panel discussion which highlighted the two-day conference.

Members of the panel leading the general discussion were: Harry Autrey, River Brand Rice Mills, Houston, Texas, panel leader; George B. Blair, American Rice Growers, Lake Charles, La.; Mrs. Florence M. Douglas, C. E. Grosjean Rice Milling Co., San Francisco, Calif.; William J. Duffy, Jr., Rice Growers Association of Calif., Woodland; and Kenneth K. Keneaster, Uncle Ben's, Inc., Houston.

To facilitate and promote research, Wm. M. Reid, president of the Rice Millers' Association, offered a resolution calling for the appointment of an industry committee to be composed of two members from each of the rice growing states, Arkansas, California, Louisiana, Mississippi, and Texas. The resolution was adopted unanimosuly, and membership of the committee will be determined promptly.

Discussions on qualities in rice desirable for export referred to results of studies by the Southern and Western Divisions, carried on in cooperation with the Foreign Agricultural Service and other agencies on some 540 samples of foreign rices, samples, of which were drawn from channels of world trade.

It was generally agreed that quality is a big factor in the export market, but that "quality" boils down to a matter of what the consumer wants, and consumers in different parts of the world want different things. One of the commonest differences is in the preference for a sticky rice versus a dry, fluffy type, but many other characteristics may play a part. The preference of Bolivians for "stack-burned" rice,

that is, grain which has overheated during drying, was cited as an example of a national preference.

California, which grows mostly short-grained Japonica varieties, has found export markets for a large part of its crop among the countries that prefer this type. California representatives present said that California could have sold additional quantities if it had been available.

Solution to the export problem, it was agreed, is primarily knowledge of the kind of rice wanted in various areas, and the production of types aimed at specific markets. It was suggested also that a revision of grading standards for export rice might be necessary in the next few years to help meet the demand for a low-priced product in some foreign markets. Doubt was expressed that loosening of grade requirements would have much effect, however, as the price is largely dependent on the price paid the grower for rough rice.

The United States rice crop grosses more than a quarter of a billion dollars a year, Mr. Duffy said, declaring that more research is urgently needed.

Mr. Blair urged that the greatest need of the entire industry at present is research on the physical and chemical characteristics of rice. This is absolutely essential, he said, to research on drying, milling, storage, and any phase of processing, because even with two samples of the same variety different results are often obtained, and until it is known what is in the grains there is no way of knowing what causes these differences. Such studies on the chemistry and physical properties of rice have been given top priority in the research recommendations of the Rice Research and Marketing Advisory Committee for the past ten or twelve years, it was pointed out.

The conference, which was the first general meeting on rice research held at the Southern Laboratory in several years, was attended by nearly 60 representatives of the rice industry and research agencies from Arkansas, California, Illinois, Louisiana, Maryland, Minnesota, Mississippi, Tennessee, and Texas.

C. H. Fisher, Director of the Southern Division, opened the meeting with welcoming remarks. V. H. McFarlane, SU, presided at the first session which was given over to reports on rice utilization research at the Western and Southern Divisions. Ernest Kester described the current program of rice research at the Western Division, and W. D. Ramage discussed improved techniques for drying western-grown rice. J. J. Spadaro, of the Southern Division, discussed adaptation of these techniques to southern-grown rice. H. J. Deobald outlined rice research at the Southern Division, and J. T. Hogan reported on humidity control in rice milling as a method of improving rice quality.

The afternoon session, with E. L. Patton of the Southern Division as chairman, was devoted to discussion by representatives of industry groups from the various states on some of their more pressing problems.

Need for profitable uses for large quantities of rice hulls, which now constitute a disposal problem, was emphasized. Speakers also stressed the need for investigations of chemical residues in rice and rice products, and changes in rice during storage, and more information on fertilizers, insect and weed control, and other cultural problems. Spoilage of harvested rice in storage was cited as a problem in Louisiana. Speakers were Mr. Autrey, representing the Texas growers; Harry Chalkley, a rice producer, and Ernest E. Edmundson Jr., a miller, representing Louisiana, and Mr. Duffy, representing California. Leon Garot, speaker for the Arkansas rice growers, was unable to attend, along with other industry representatives from that state, because of weather conditions.

Mr. Reid presided at the second day's session. Speakers preceding the panel discussion were Dwight C. Finfrock, of the California Agricultural Experiment Station, Biggs, who presented data to show that increased yields accompanied increased plant population in California rices, even though the yield per head might be lower. A. B. Watts, of the Louisiana Agricultural Experiment Station, discussed the use of rice hulls and other rice byproducts in feeds as large potential outlets for these materials.

Some research approaches to various problems were described by G. W. Kohler, of the Western Division. He suggested that protein may be a factor in determining some of the cooking qualities of rice, and said methods that have been developed through research on wheat may be useful in studying this problem. He suggested storage of rice under inert gas to improve keeping qualities, pointing out that this has proved economically feasible for alfalfa meal, which sells for about half the price of rice.